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DEPARTMENT OF MINES

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Geology of
Rickard, Knox, and Kerrs Townships
District of Cochrane

By

Compliments of
P. S. SIMONY
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GEOLOGICAL MAP
(Back pocket)

Map No. 2073 (coloured)—Rickard, Knox, and Kerrs townships, District of Cochrane. Scale, 1 inch to ½ mile.

Abstract

Three townships (Rickard, Knox and Kerrs), in an east-west belt along the Abitibi River west of Lake Abitibi and 40 miles northeast of Timmins, were mapped on a scale of 1 inch to ¼ mile during the summer of 1963. The map-area is in the "clay belt" in northern Ontario and near the northern edge of the great "greenstone belt" containing the Porcupine and Kirkland Lake mining camps.

The bedrock of the area is all Precambrian in age and consists mainly of andesite and basalt flows of the Keewatin type. Andesitic agglomerate and acid flow-rocks form a minor part of the volcanic pile whose thickness may be as much as 15,000 feet. Sills of gabbro and serpentinite and dikes of feldspar porphyry and diabase intrude the volcanic succession.

Key-map showing location of the Rickard, Knox, and Kerrs map-area. Scale, 1 inch to 50 miles.

The volcanic rocks were first folded into isoclines with vertical axial planes striking east-west and then later warped into open folds with vertical axes and northeast-striking axial planes. The rocks are massive, metamorphism is slight, and original textures and structures are well preserved.

Gold was found associated with quartz-carbonate veins and carbonatized zones. Pyrite and other sulphides are concentrated in acid volcanic bands. Asbestos occurs in serpentinite near Lake Abitibi. Unconsolidated Pleistocene sand, gravel, and clay deposits are widespread and as much as 200 feet thick in places. Varved clay suitable for making brick and tile occurs in the area.

Geology of

Rickard, Knox, and Kerrs Townships

By

P. S. Simony[1]

Introduction

The townships of Rickard, Knox, and Kerrs lie in an east-west belt straddling the Abitibi River between Twin Falls on the west and Lower Lake Abitibi on the east. The western boundary of Rickard township is 6 miles east of Iroquois Falls and 40 miles northeast of Timmins.

As shown on O.D.M. map No. 2046 (Timmins–Kirkland Lake Compilation Sheet), the map-area is near the northern edge of the "greenstone belt" containing the Porcupine and Kirkland Lake mining camps.

Prospecting for gold has been carried out in the area since the beginning of the present century. In 1917 gold was discovered in lot 7, concession IV, Rickard township. In recent years there has been widespread prospecting for gold, base metals, and asbestos in northeastern Ontario where the map area is located. A strong magnetic anomaly along the eastern boundary of Kerrs township was investigated by drilling during 1963.

The present survey was carried out during the summer of 1963 and is part of a systematic program to remap in detail large parts of northeastern Ontario and thus provide the kind of geological maps essential to modern exploration programs.

Field mapping was done on a scale of 1 inch to ¼ mile. The basemap was compiled from maps of the Forest Resources Inventory, Ontario Department of Lands and Forests. In spite of careful search, survey posts were not found on township lines. The geological data were plotted on transparent plastic (perfatrace) overlays on vertical air photographs of about the same scale as the basemap.

It was possible, by using the air photographs in conjunction with earlier geological maps, to outline with some certainty areas of outcrop, scattered outcrop, possible outcrop, and definitely no outcrop. In the areas of continuous and scattered outcrop, every exposure was visited, and traverses were run between outcrops in search of further outcrop. Areas of possible outcrop were traversed at intervals of 20 chains. Areas expected to be devoid of outcrop were traversed at intervals of 20 to 40 chains; with lines of traverse planned, in many instances, to intersect prominent drift features. Areas of extensive spruce swamp

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and open muskeg were not traversed as a rule because outcrops in such terrane would be clearly visible from air photographs.

The outcrop area around Twindyke mine in Rickard township was mapped on a scale of 1 inch to 100 feet on a basemap modified from one submitted to the Ontario Department of Mines for assessment work credit by Rio Tinto Canadian Exploration Limited.

Acknowledgments

The author was ably assisted in the field by P. Van de Kamp, C. Michelutti, P. Hatfield, and J. Lochner. Mr. Van de Kamp, as senior assistant, was responsible for mapping about half the area.

The party is appreciative of the help and co-operation received throughout the summer from the personnel of the Abitibi Power and Paper Company Limited.

Means of Access

The Abitibi River flows through the three townships and thus affords easy access to most parts of the area from Twin Falls. A private motor road connects the dam at Twin Falls with Iroquois Falls just over 6 miles east of highway No. 11. A spur line of the Ontario Northland Railway serves Iroquois Falls. A wagon road goes from Twin Falls to Twindyke mine in the central part of Rickard township. The part of the road between Twin Falls and the nearest boundary of Rickard can be used by motor cars; the rest of the road is only suitable for tractors or wagons.

A road fit for use by motor cars—at least during the summer of 1963—connects a small lake on the east boundary of lot 1, concession III, Kerrs township, to highway No. 101, east of Matheson.

Previous Geological Work

Rickard, Knox, and Kerrs townships are included in map No. 28b accompanying the report on the Abitibi–Night Hawk gold area by C. W. Knight *et al.* (1919). The three townships are also included in the Iroquois Falls–Lake Abitibi Sheet (Ont. Dept. Mines map No. P.140) and the Timmins–Kirkland Lake Compilation Sheet (O.D.M. map No. 2046).

The surficial geology of the map-area is shown on map No. 46-1959 of the Geological Survey of Canada.

Maps from several mining companies submitted for assessment work credit to the Ontario Department of Mines were available to the author.

The following aeromagnetic maps include the three townships:

Map No. 296G—Matheson; Geol. Surv. Canada, 1956.

Map No. 297G—Porquis Junction; Geol. Surv. Canada, 1956.

Map No. 2337G—Iroquois Falls; Ontario Dept. Mines and Geol. Surv. Canada, 1964.

Map No. 2355G—Bingle; Ontario Dept. Mines and Geol. Surv. Canada, 1964.

Topography

The map-area is, in general, one of low relief. It consists of an undulating clay plain at an elevation of about 900 feet. A few sand ridges and bedrock hills rise another 200 feet or so above the plain.

The highest point in the area is at the top of a bedrock hill in lot 5, concession I, Knox township. This point is known locally as Fire Tower Hill. It is marked by triangulation station "Knox" at an elevation of 1,138 feet.

View toward the southeast from the top of "Fire Tower Hill" in lot 5, concession I, Knox township. Note how the flat skyline of the clay plain makes such an abrupt contrast with the outcrop hill in the foreground.

Most of the area is drained by the Abitibi River flowing westwards from Lower Lake Abitibi. The dam at Twin Falls has raised the level of the river to such a height that the valleys of many of the tributaries are now drowned and thus form long inlets. Several of the outcrops shown on the Abitibi River in map No. 28b (Knight *et al.* 1919) are now covered with water. Drainage of the clay is not effective and large areas are forested swampy ground and open muskeg.

Except for Lake Abitibi itself (and only a small fraction of this is included in the map-area), the area contains few lakes, most of them scarcely better than kettle lakes and other water-filled depressions in the sand and gravel deposits. Bobs Lake in Knox township is an exception to the rule: it fills a depression in the bedrock and is elongated parallel to the strike of the volcanic rocks.

Outcrop is restricted to the part of the area south of the Abitibi River. There are three major outcrop areas: (1) in the centre of Rickard township; (2) in the southern part of Knox township and extending into the southwestern part of Kerrs township; and (3) around Couchiching Falls in Kerrs township.

Natural Resources

Pulp and paper is the most important industry in the area. Abitibi Power and Paper Company Limited operates the power dam at Twin Falls; in the spring and early summer it moves large quantities of pulpwood down the Abitibi River.

Some trapping is done; fish and game are plentiful. No land has been cleared for farming.

General Geology

The map-area is located, geologically, near the northern edge of the largest Archean greenstone belt in northern Ontario. The important mining camps of Porcupine and Kirkland Lake are in this belt (*see* O.D.M. map No. 2046). The area also lies within the great "clay belt" of northern Ontario. Outcrop is therefore limited, and large parts of the area are underlain by varved clay.

The bedrock of the area is all Precambrian in age and consists mainly of Keewatin-type andesitic and basaltic flow rocks. Thin andesitic agglomerate, acid flows, and tuff bands are also present as minor components of a volcanic succession amounting to an aggregate thickness of about 15,000 feet.

Except in narrow shear zones, the volcanic rocks have undergone little metamorphism or internal deformation, and the original textures and structures are well preserved.

The volcanic rocks are intruded by sill-like bodies of gabbro and serpentinized peridotite, identical with rocks occurring elsewhere in the same greenstone belt and called Haileyburian because they can be shown to be older than the Algoman granites.

Large acid intrusive bodies are not exposed within the area; but to the east, on Lake Abitibi, the volcanic rocks are intruded by Algoman granite dated as being 2,545 million years old (Lowden *et al.* 1962).

A few narrow dikes of feldspar porphyry are widely scattered over the area. They are similar to porphyry dikes referred to the Algoman in other areas.

The youngest intrusive bodies in the area are diabase dikes ranging in width from 6 inches to 300 feet. At least two types and ages (?) of diabase are recognized: quartz diabase with large phenocrysts (Matachewan?), and diabase with little or no quartz and locally a little olivine (Keweenawan?).

The volcanic rocks were folded into tight isoclinal folds, thus giving these flows the uniformly steep dips and the east-west to southeast strike commonly observed in much of the Superior province. The steeply dipping flows were later warped into open folds. Minor faulting and shearing appear to postdate the folding but to predate the intrusion of diabase.

In large parts of the area, the bedrock is overlain by as much as 200 feet of Pleistocene sediments, with varved clay as the most important of these sediments. Locally, bouldery deposits intervene between the bedrock and the clay. A number of north-south-trending sand and gravel ridges, in part buried by the clay, represent eskers subsequently covered and in part reworked by the waters of the lakes in which the varved clay was deposited.

Keewatin(?)

The oldest rocks of the area, and by far the most abundant, are a series of basaltic and andesitic flows that dip steeply and strike generally in an east-southeast direction. They are exposed as a belt occupying the more southerly parts of the three townships. Thin acid lava, agglomerate, and tuff bands are interbedded with the basic flows.

TABLE OF FORMATIONS

CENOZOIC

RECENT:	Swamp and stream deposits.
PLEISTOCENE:	Varved clay and pebbly beach deposits. Sand and gravel (eskers). Boulders, till (ground moraine).

Unconformity

PRECAMBRIAN

PROTEROZOIC

KEWEENAWAN(?)	Diabase, olivine diabase.

Intrusive Contact

MATACHEWAN(?)	Quartz diabase, porphyritic quartz diabase.

Intrusive Contact

ARCHEAN

ALGOMAN(?)	Feldspar porphyry.

Intrusive Contact

HAILEYBURIAN(?)	Gabbro, diorite, serpentinized peridotite.

Intrusive Contact

KEEWATIN(?)	Rhyolite, trachyte and rhyodacite, acid and andesitic tuff and agglomerate.
	Andesitic and basaltic flows (including pillow lava), massive flows, amygdaloidal and brecciated lava.

Rickard, Knox, and Kerrs Townships

No sedimentary rocks can be found in the three townships except for thin bands of rusty schist, chert, and iron formation originally reported by Knight *et al.* (1919) from outcrops now flooded by the Abitibi River.

Pillow lava northwest of Bobs Lake in Knox township. The beds face away from the observer. Note the distinct selvages.

A large number of individual volcanic flows have been identified and a variety of rock types recognized. Most of the prominent flows can be traced along strike for distances of only a mile or so. Consequently little justification exists for assigning names to individual volcanic units. Top determinations could be made on many outcrops and the order of succession established. The flows range in thickness from 10 to 1,000 feet. The entire volcanic succession exposed in the map-area is about 15,000 feet thick.

TABLE I—MODES OF VOLCANIC ROCKS

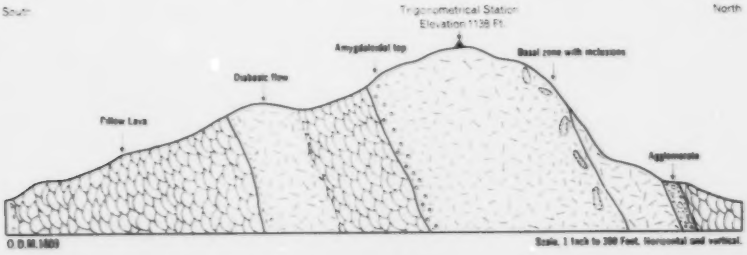
Minerals	No. 1	No. 2	No. 3	No. 4
	percent	percent	percent	percent
Plagioclase	58.3	54.4	62.3	43.2
Pyroxene	30.4	31.3	28.4	46.4
Quartz	4.2	3.3	4.2	2.0
Chlorite	3.5	7.0	3.0	5.4
Magnetite	4.6	4.0	2.1	3.0

No. 1—Average of three samples from the massive flow forming "Fire Tower Hill", lot 5, concession I, Knox township.
No. 2—Average of four samples from the long massive flow north of Bobs Lake, Knox township.
No. 3—Average of five samples of medium-grained andesite from flows near Bobs Lake, Knox township.
No. 4—Average of two samples of basalt from flows near Bobs Lake, Knox township.

For mapping purposes the volcanic rocks were divided into two major groups: (1) basaltic and andesitic rocks; and (2) acid rocks. On the basis of colour index the rocks of group (1) were divided into two types: (1a) paler rocks and (1b) darker rocks. Thin-section study of the various types suggests that colour does roughly indicate composition: thus the paler (1a) rocks are andesitic and the darker (1b) rocks are basaltic. But it must be remembered that colour is not an entirely reliable guide to composition. Thus outcrops marked (1a) would, for example, ordinarily be interpreted as pale-greyish or brownish green rocks, probably andesitic in composition. Locally, though, carbonatization and other alterations have given the basaltic rocks a pale colour.

Greenish grey pillowed andesite flows are among the most prominent of the rocks of the area. Many of these flows are hundreds of feet thick; northwest of Bobs Lake in Knox township they are nearly a thousand feet thick and apparently show no break. Among the dark basaltic flows of Rickard and Kerrs townships, pillows and selvages are similar in colour, thus making the pillows indistinct. The pillows vary in shape and size from small 6-inch spheres to great "mattresses", several feet thick and 10 feet long, draped over smaller underlying pillows. The central part of some of the pillowed flows contain irregular zones of massive lava. Interstices occurring where pillows do not quite fit together are filled with quartz and calcite.

Several massive flows are interbedded with the pillow lava. They are lenses up to 800 feet in thickness and with a strike length of a mile or so. One such flow north of Bobs Lake was traced for 5 miles from lot 12, concession II, Kerrs



North-south cross-section of "Fire Tower Hill"; lot 5, concession I, Knox township, looking west.

township, to lot 10, concession IV, Knox township. The lower and central parts of these flows have a coarse diabasic or even gabbroic texture and are locally porphyritic. The phenocrysts are completely altered equant crystals of feldspar occurring in aggregates.

At their base the massive flows have sharp chilled contacts with the underlying flows and locally contain tabular inclusions of these flows. Near the top, the thick massive flows become progressively finer-grained upwards, and their tops are amygdaloidal and brecciated. These relations are well illustrated by the flow that forms Fire Tower Hill in the northwest part of lot 5, concession I, Knox township.

The upper part of a long massive flow is well exposed in the north half of lot 3, concession II, Knox township. This flow is overlain by an andesitic tuff-breccia about 100 feet thick. The surface immediately underlying the tuff is irregular and locally it cuts through the upper fine-grained part of the massive flow down into the coarser-grained part below.

Unless these upper surface features of the massive flows are well exposed, and unless the continuous gradation from the coarse middle part to the fine-grained top can be demonstrated, the coarse massive flows are indistinguishable from diabase sills.

The pillow lavas are, for the most part, too fine-grained and too much altered to allow of precise identification of their constituents. The former presence of plagioclase laths and of grains of pyroxene and magnetite arranged in intersertal texture can be recognized. The plagioclase is not fresh enough to permit of optical determination of its anorthite content and thus to enable one to recognize the presence of abnormally sodic basalt (spilite).

Original minerals and textures are well preserved in the coarse-grained massive flows. Large grains of pyroxene (augite) ophitically enclose laths of partly altered plagioclase; 2 or 3 percent magnetite and as much as 5 percent primary quartz are common. In the darker rocks, the plagioclase is generally labradorite or calcic andesine (An_{55-40}), and constitutes 40–50 percent of the rock. In the paler rocks, the plagioclase is usually andesine (An_{30-50}), and makes up 60–70 percent of the rock. These less basic rocks differ from the coarser basalts only in their plagioclase content and in the anorthite content of the plagioclase. Consequently these rocks are best described as basaltic quartz andesite.

Modes of representative specimens are given in Table I. Fragmental rocks such as breccia, agglomerate, and tuff, though widespread in the area, account for only a minor proportion of the volcanic pile. The two most common fragmental types in the area are andesitic agglomerate and flow-top breccia. These both occur as thin bands between thicker basalt and andesite flows. A series of diabasic flows 20–200 feet thick, each topped by a breccia flow 1–3 feet thick, occurs southwest of Bobs Lake in lots 8 and 9, concession II, Knox township.

The breccias consists of angular fragments of andesite or basalt in a rusty schistose matrix rich in chlorite and calcite. The base of each breccia band is an irregular surface with large fragments from the underlying flow resting on top of it; upwards the fragments become smaller. Locally, breccia fills fractures extending as much as 6 feet down into the underlying flow. The surface separating the breccia from the next flow above was found to be either flat or gently undulating.

Agglomerate is found, as a rule, in narrow bands 10–100 feet thick. These bands vary a great deal in thickness along strike. Agglomerate bands could not be traced with confidence for more than half a mile along strike. This agglomerate typically consists of a rusty-weathering chlorite carbonate matrix containing small angular fragments of andesite, dacite, and trachyte. Embedded in the matrix, along with the small fragments, are spindle-shaped bombs. These are as much as 2 feet long and 4 inches in diameter. They are crusted with a dark-brown scale. They are mainly andesitic.

Some of the agglomerates contain large blocks of the underlying rock types in addition to the fragments and bombs. Locally the surface beneath the agglomerate is highly irregular and agglomeratic debris fills deep fissures in these underlying volcanic rocks.

Acid volcanic rocks are rare within the area. They occur in the form of bands of rhyolite, rhyodacite, trachyte, and acid tuff. Some of these siliceous bands in the vicinity of Twindyke mine were considered to be chert (Knight *et al.* 1919); but careful examination of the outcrop reveals that it is locally laminated

and contains angular fragments. In thin section the laminae are seen to be graded tuff layers just a few millimetres thick. The fragments are rhyolite containing small phenocrysts of quartz and feldspar.

Acid bands near Bobs Lake are carbonatized amygdaloidal rhyodacite with quartz and calcite amygdules.

The long massive flow northeast of Bobs Lake is overlain for most of its length by a thin band of acid rock. This rock is a tuff-breccia consisting of angular fragments of rhyolite, trachyte, and andesite set in a schistose-tuff matrix. It is well exposed, in concession II, in a group of outcrops on both sides of the Knox-Kerrs township boundary. In one small outcrop in lot 8, concession III, Knox township, the tuff-breccia is overlain by a thin band of spherulitic rhyodacite.

METAMORPHISM

All the volcanic rocks are partly altered; locally they are sheared. In general, though, the alteration has not entirely destroyed their original composition; and original textures and structures are rarely deformed. In the massive coarse-grained rocks, pyroxene is virtually unaltered, and feldspar, though altered, remains identifiable. The alteration minerals are calcite, quartz, zoisite, uralite, and chlorite. Vesicles in the volcanic rocks are filled with calcite, quartz, and chlorite.

Some basic and intermediate rocks contain black specks. In some bands these are small vesicles filled with chlorite; but in others they are large flakes of chlorite in the main rock mass. Probably these chlorite specks are of metamorphic origin. They are most abundant in Kerrs township: thus perhaps indicating a slight rise in metamorphic grade from Rickard township eastward to Kerrs township.

The preservation of most of the original minerals and textures, combined with the assemblage of new minerals, indicates that the rocks were metamorphosed under conditions experienced in the lower-grade part of the greenschist facies. This low grade of metamorphism is noteworthy when the proximity of the area to the large granitic masses to the north and to the east is considered.

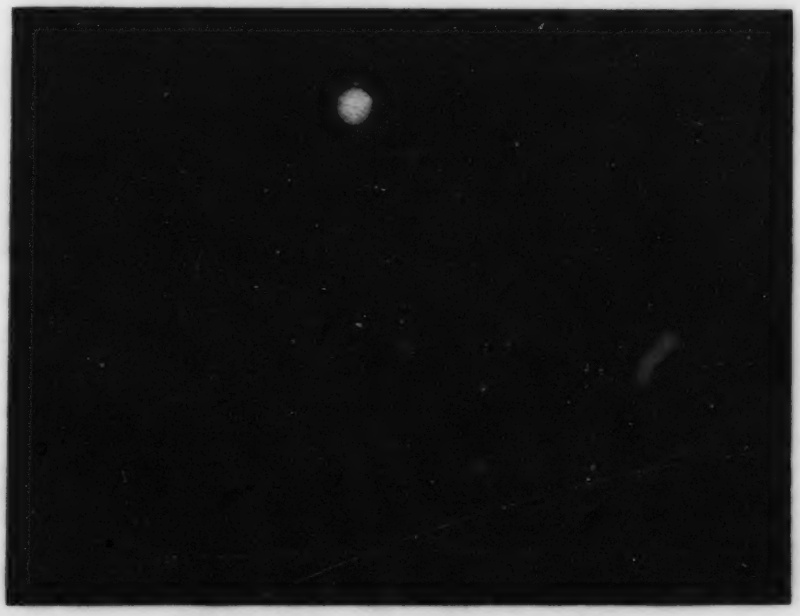
MODE OF ORIGIN

The abundance of pillow lava suggests that the flows were poured into large lakes or into a marine basin. Complete absence of interbedded sedimentary rocks in a volcanic sequence 15,000 feet thick implies that sedimentation was either not active in the region or vulcanism was so continuously active as to prevent sedimentary layers from forming between flows. The great thickness of some of the flows and the widespread occurrence (though in small quantities) of agglomerate containing bombs as much as 2 feet long combine to suggest a fairly close source for the volcanic material. But no such source—volcanic centre or feeder dike—could be found.

CORRELATION AND AGE

Correlations are difficult to establish in this area owing to the extensive clay covering. A large gap without outcrop occurs between the south-facing flows at the Coulson-Knox township boundary and the south-facing flows in the southwestern part of Coulson township (Leahy and Ginn 1961). If no folds intervene in the obscured ground, then the flows in southern Coulson are 15,000–20,000

Flow-top breccia; lot 9, concession II, Knox township. The breccia is the pale rock under the hammer-head. Note the irregular surface at the top of the flow (below and to right of breccia).



Bombs in agglomerate; lot 9, concession II, Knox township.

feet above the Knox-Kerrs flows in the stratographic sense, but, allowing for a syncline-anticline intervention, then the rocks in southern Coulson may be at about the same stratigraphic level as the Knox-Kerrs flows.

The flows exposed in Rickard, Knox, and Kerrs townships are probably intruded, to the east on Lower Lake Abitibi, by Algoman granite masses; so these flows may be regarded as being Archean. It is not known whether these Keewatin(?) flows of the map-area are correlative with the volcanic rocks lying unconformably below the Timiskaming rocks, and identified as Keewatin in the Porcupine and Kirkland Lake mining camps.

Haileyburian (?)

In the eastern part of Kerrs township there is a strong hook-shaped magnetic anomaly (Maps 296G, 2355G) which continues east to Lake Abitibi. On Lake Abitibi, the rocks exposed within the anomaly are serpentinized peridotite surrounded by gabbro. These rocks are not exposed in Kerrs township. It is

Asbestos veinlet in a peridotite mass exposed on Lake Abitibi.

probable, therefore, that within Kerrs township the anomaly represents a narrow band of serpentinite flanked by gabbro. On Lake Abitibi the serpentinite consists largely of olivine grains pseudomorphed by serpentine and of minor amounts of pyroxene and magnetite. Serpentine also occurs in shear zones and as cross-fibre asbestos in fractures.

These rocks are identical with other serpentinized bodies in the Abitibi peridotite belt (Hewitt and Satterly 1953) and are probably of the same age.

Knox and Rickard townships contain bodies of massive gabbroic rock These bodies cannot be demonstrated to be massive flows and some of them

appear to have discordant contacts. Possibly, therefore, they represent intrusive gabbro. In thin section the rocks are seen to consist of partly altered augite and labradorite and to be similar to the coarse gabbroic flows.

Quite possibly the bodies mapped as Haileyburian(?) intrusive gabbro are in reality thick massive basalt flows.

Algoman (?)

Small dikes of syenitic feldspar porphyry are widely scattered throughout the area. Their width has had to be exaggerated on the map in order to record them at all; and they are only a few feet thick in several outcrops.

Variations occur from dike to dike; but certain common characteristics may be identified:

1. The porphyries are essentially syenitic despite the existence of four dikes (two in Rickard and two in Kerrs) having a little quartz in their groundmass and also having a few rounded and partly resorbed quartz phenocrysts.

2. They all have partly altered phenocrysts of sodic plagioclase and orthoclase. Many have partly altered phenocrysts of hornblende displaying a weak greyish green pleochroism.

3. They all have a fine-grained groundmass of feldspar and hornblende with a little chloritized biotite and accessory apatite and magnetite.

TABLE II—MODES OF DIKE ROCKS

Minerals	No. 1	No. 2	Minerals	No. 3
	percent	percent		percent
Plagioclase	46.9	59.3	Phenocrysts:	
Pyroxene	36.7	33.2	Plagioclase	10.0
Olivine	—	—	Orthoclase	2.2
Biotite	—	—	Quartz	1.3
Chlorite	—	—	Hornblende	10.0
Quartz	—	—	Groundmass:	
Magnetite	—	—	Feldspar	51.1
			Hornblende	25.4

No. 1—Average of eight Keweenawan(?) diabase samples.
No. 2—Average of three Matachewan(?) diabase samples.
No. 3—Average of three Algoman(?) porphyry samples.

The dikes vary mainly in the abundance of phenocrysts and proportion of hornblende. Some dikes have as much as 35 percent hornblende; others consist almost entirely of feldspar. Only one dike—at Couchiching Falls in Kerrs township—was found to have any sulphide mineralization.

The porphyry dikes are similar to dikes described from many areas in northeastern Ontario and generally ascribed to the Algoman.

Matachewan (?)

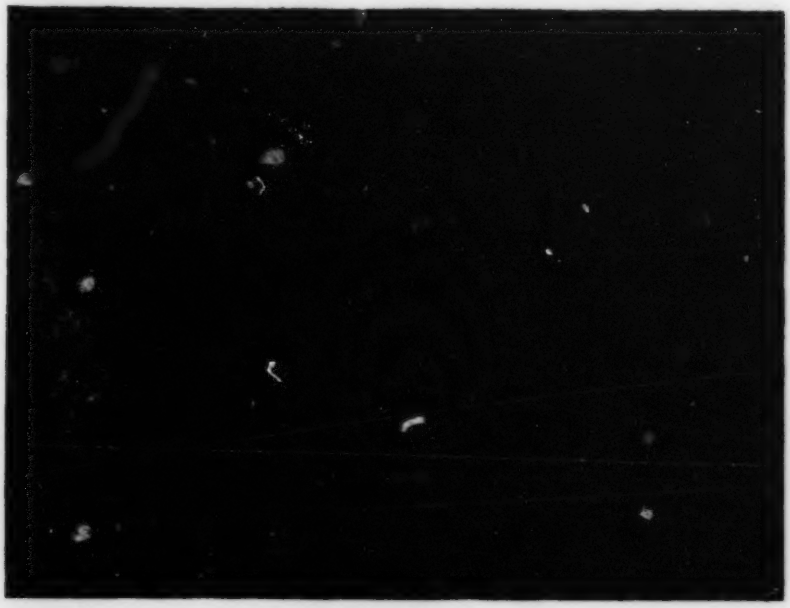
Diabase dikes containing large phenocrysts of calcic plagioclase are exposed in all three townships. These phenocrysts have acquired, due to alteration, a waxy lustre and a yellowish green colour. They frequently occur in clusters of greatly varying shape. Clusters with a diameter of 3 inches were seen in a large dike near the western boundary of Knox township. The phenocrysts are not evenly distributed throughout the dikes but, rather, occur in swarms elongated parallel to the axes of the dikes.

The diabase has an ophitic texture and consists mainly of fairly fresh plagioclase (sodic labradorite) and fresh pyroxene (augite). All specimens were found

to contain 2–5 percent of granophyric intergrowth of the feldspar and quartz and 2–3 percent magnetite.

The dikes vary in thickness from a few inches to about 400 feet; several could be traced for more than 1 mile along strike. They all have a general north-south trend.

These dikes are similar in every respect to the ones described by Dyer (1936) from the Matachewan-Kenogami area and first called "Matachewan" by Miller (1923). In the Matachewan area, the dikes cut Algoman rocks and are overlain unconformably by conglomerates of the Cobalt Group (Dyer 1936, p. 25). Cobalt rocks are not present in the map-area and the age of the dikes cannot be



Group of large altered phenocrysts in Matachewan (?) diabase; lot 13, concession IV, Knox township.

checked; but, in view of their strong resemblance to the original Matachewan dikes, they, too, are probably of Matachewan age.

Keweenawan (?)

Diabase dikes lacking large altered feldspar phenocrysts were not mapped as Matachewan(?) and are tentatively assigned to the Keweenawan. Although the absence of phenocrysts was the main criterion used in the field, many of the Keweenawan(?) dikes differ from the Matachewan(?) dikes in other respects:

1. They contain less quartz and granophyre.
2. They are generally fresher.
3. They contain small flakes of reddish brown biotite.
4. Some of them contain olivine.

In some dikes, roundish aggregates of iddingsite and serpentine may represent altered olivine. Olivine was positively identified in three dikes in Knox town-

ship: it is hyalosiderite (Fa_{35-40}). Magnetite was found in all samples; in some it constitutes 5 percent of the rock.

A dikelet about a foot wide in the southern part of lot 2, concession II, Knox township, consists of fresh phenocrysts of olivine and labradorite in a groundmass of small plagioclase laths and pyroxene granules.

The large dike passing through Kerrs township and the southeast part of Knox has a weak but distinctly evident anomaly associated with it; and was traced by this means over much of its length. The outcrop in Knox township shows that it occurs in two segments, at the present level of erosion. The magnetic anomaly, although weaker over the gap, is continuous. This dike is coarser than all the other dikes of the map-area and weathers in a peculiarly crumbly manner. Some samples from the dike contained quartz; others olivine.

The dikes mapped as Keweenawan(?) strike north-south and northeast. Possibly the two trends represent two ages of intrusion; perhaps some of the north-south-trending dikes mapped as Keweenawan(?) should be grouped instead with the Matachewan(?) dikes in spite of their mineralogical differences.

Pleistocene

The Pleistocene geology of the Abitibi region as a whole has been discussed by several authors: notably by Coleman (1909) and by Knight *et al.* (1919). The surficial deposits are well summarized on map No. 46-1959 of the Geological Survey of Canada.

Unconsolidated Pleistocene deposits cover the bedrock in large parts of Rickard, Knox, and Kerrs townships. Diamond-drilling in lots 1 and 2, concession III, Kerrs township, and in lot 1, concession V, Rickard township, has indicated, when taken in conjunction with evidence provided by hillside exposures, that the Pleistocene deposits of this locality may be as much as 200 feet thick. Three types and ages of deposits can be recognized:

1. Boulders and clay resting on bedrock (ground moraine).
2. Sand and gravel ridges (eskers).
3. Varved clay, well bedded and sorted sand, and local pebble deposits (glacial lake deposits).

Erratic boulders and till are rare. They typically occur as a thin veneer in outcrop areas or as a fringe around outcrops. But boulders or boulder clay do not always intervene between bedrock and other types of deposits. Sand, gravel, and clay rest directly on the bedrock in many localities.

Glacial striae are rare. The direction of ice movement, as indicated by five striae readings, is between S.32°E. and S.20°W.

Three large elongate sand and gravel deposits trend south-southeast across the area: one in the western part of Rickard township, one in the southwest part of Kerrs township, and the third and largest along the eastern boundary of Kerrs township. In all three deposits a central "backbone" consisting of boulders, pebbles, and coarse sand can be recognized. This is the esker proper. It is flanked by bedded pebbly sand and sand and silt deposits extending as much as a mile outwards from the esker.

These sand deposits interfinger with, and are covered by, varved clay. They probably represent esker material reworked by waters of the lake in which the varved clay was deposited. Clay can be observed lapping onto and covering esker deposits along the narrows of the Abitibi River near the Knox-Kerrs town-

ship boundary. The patchy occurrences of sand and gravel in the southeast part of Knox township probably represent another esker; but this one has been partly buried by the clay and also partly destroyed by lake erosion prior to the deposition of the clay.

Varved clay is the most widespread of the Pleistocene deposits in the area. Thicknesses of 15–20 feet can be observed along the Abitibi River; probably thicknesses of 50 feet exist. The clay lies on esker material, till, and bedrock. It is clearly the youngest of the Pleistocene deposits in the area and represents a stage in history when the area was covered by the large glacial lake Ojibway-Barlow.

Varved clay occurs up to elevations of 950 feet above sea level in the southeast part of Knox township. Pebble and cobble deposits, probably representing lake beaches, were found on the sides of prominent hills in the township. The highest beach is at 1,100 feet on the side of Fire Tower Hill in lot 5, concession I, Knox township. These elevations correspond fairly well with those established to the south in Munro township (Satterly 1952).

The clay is of a greyish brown colour with varves ¼–1 inch thick. In some sections, particularly in Knox township, the varves are well-developed dark-brownish layers ½–⅜ inch thick alternating with yellowish layers ⅛–¼ inch thick. But in the eastern parts of Rickard township, along the Abitibi River, the varves are only faintly developed and the clay is uniformly brown in colour and of blocky form. The firm fresh clay breaks with a conchoidal fracture; when wetted, though, it becomes plastic and may be readily moulded. Even the paler layers are so fine and rich in clay minerals that they do not feel gritty between the fingers.

An attempt was made to classify the various rock types occurring as boulders embedded in the till, eskers, and beach deposits. Pink granite is the most dominant rock type by far. Diabase, gneiss, and basic volcanic rocks form a secondary group. Quartzite, argillite, mica schist, and fossiliferous limestone are rare.

Structural Geology

Folding

The lava flows all have steep to vertical dips. They are overturned in Kerrs township and in the eastern part of Knox township. On the map they outline a pair of broad folds forming an open-Z structure. The volcanic rocks strike N.90°E.–S.70°E. In the western half of Knox township the strike gradually swings in such a manner that, near the western boundary of Knox and just south of the Abitibi River, the strike is nearly north-south. But, as indicated by information derived from map 28b (*see* Bibliography), the strike is again roughly east-west in the northwestern part of Rickard township.

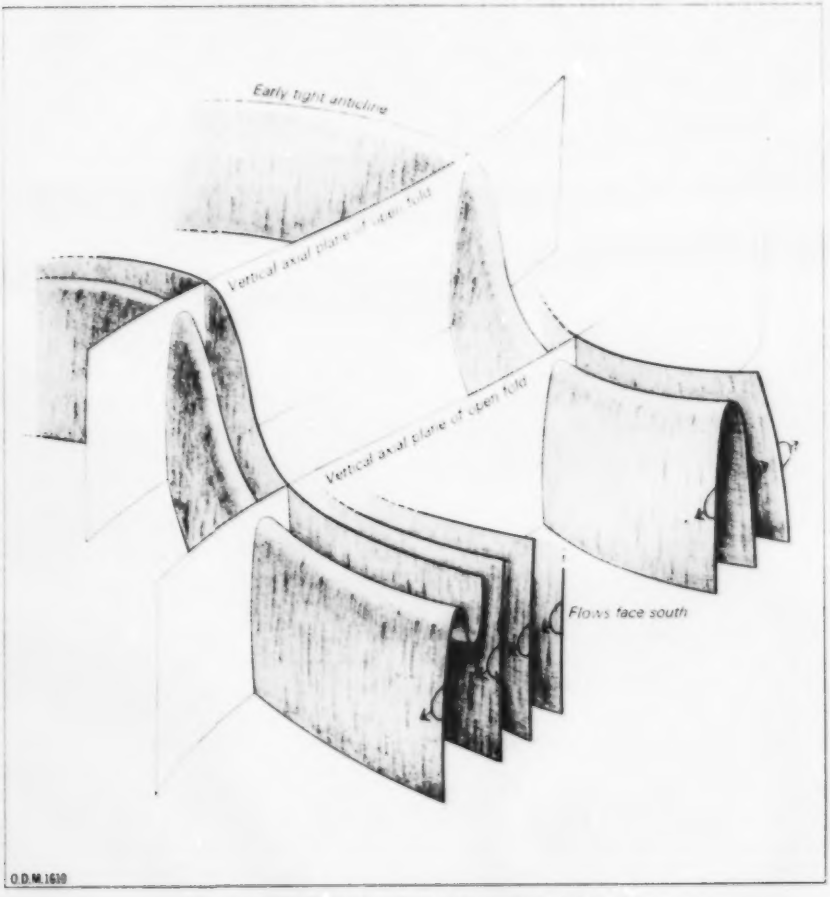
To draw the trace of the axial plane of such broad open folds is difficult; so the lines drawn on the map are only approximate. The trace of the more southerly axial plane is drawn as curving northwards through Knox township on the basis of geophysical data obtained from Moody township directly to the north.

Aeromagnetic data gathered by airborne geophysical surveys conducted by Hunting Survey Corporation Limited in 1960 and 1961, and subsequently filed with the Ontario Department of Mines for assessment work credit, imply

the presence of an open-Z structure in Moody township similar to the one in Knox and Rickard townships and possibly having the same axial plane.

Because the flows outlining the Z-structure in Knox and Rickard townships are nearly vertical, the axes of the pair of folds making up the structure must also be nearly vertical. Furthermore, because the axis of a fold lies in the axial plane, folds with vertical axes must have axial planes with vertical dips.

In Rickard township, all flows face west and southwest, but in Knox and Kerrs townships there are zones where the directions in which the flows face are reversed. These reversals indicate the presence of folds. The folds must be isoclinal or extremely tight since the changes in direction of top are not accompanied by changes in the dip and strike of the flows. The axial plunge of these tight folds could not be determined.



Diagrammatic illustration of the fold structure of the area.

The zone of north-facing flows in the southeast part of Knox township is narrow and probably results from the presence of a pair of small folds. The fold whose axial trace passes south of Couchiching Falls in Kerrs township may be a

major anticline. It is possible that the succession of flows exposed in the southern part of Knox and Kerrs townships and lying on the south limb of the anticline are to be found again on the north limb under the covering of clay in the northern part of Knox and Kerrs townships.

The pair of open folds combining to form the Z-structure have affected the sequence of lava flows already folded once into tight or isoclinal folds. Furthermore the open folds have nearly vertical axes; so there is no point in calling them anticlines or synclines.

Faulting

Little faulting was seen in the map-area. The only major fault is one striking northeast through the southeast corner of Knox township. A topographic lineament is associated with it and the fault displaces nearly vertical flows about 400 feet in a dextral manner. Thus a measure of the strike-slip component of the fault movement is provided; but the net slip could not be calculated.

A minor northwest-trending fault occurs in lot 8, concession II, Knox township. It may have some dextral movement on it. For a part of its length, it is followed by a Keweenawan(?) dike. The strike is not sheared and probably postdates faulting.

At Couchiching Falls, in Kerrs township, a Matachewan(?) dike follows a small fault. It, too, is unsheared.

Shearing and Veining

The rocks of the area are massive in general; schistosity is developed only locally in narrow zones. Some weak schistosity approximately parallel to the dip and strike of the flows may be related to the early isoclinal folding. Schistosity is also developed nearly parallel to the axial planes of the Z-structure. Most shearing appears to postdate the folding, since the shearing directions are not affected by the folds.

Narrow shear zones, joints with minor displacements, and narrow veins are found on many outcrops. Some idea of their age relations is provided by their cutting relationships.

The oldest and most important shears strike between N.80°E. and S.50°E. These are well developed in Rickard township and in the southwest part of Knox township. East-west shears cut through Algoman(?) porphyry dikes; so they postdate the dikes. In several outcrops, east-west shears are displaced by—and therefore postdated by—northeast- and north-trending shears.

The shear zones and joints are commonly occupied by veins ½–1 inch thick. Locally, though, these veins may exceed 1 foot in thickness. They may be grouped into several mineralogical types: (1) quartz; (2) quartz and epidote; (3) quartz, epidote, and carbonate (actinolite may or may not be associated with these minerals); (4) quartz, carbonate, and sulphide; and (5) irregular epidote veins and patches.

Close correlation between age and vein mineralogy was not found. But, in general, quartz, carbonate, and sulphide veins are commoner in the early east-west shears. The youngest veins are usually simple quartz veins.

The Matachewan(?) and Keweenawan(?) dikes are unaffected by shearing and veining; so probably they postdate these events.

Economic Geology

Gold was discovered in 1917 in the south half of lot 7, concession IV, Rickard township. High gold values were found but no production is recorded. Work was done sporadically until 1958. The property is now idle.

Gold was the only valuable mineral known or searched for in the map-area until 1962 when Area Mines Limited began a program of ground magnetometer work and diamond-drilling in the search for asbestos in the serpentinite mass on the eastern boundary of Kerrs township.

Coarse sand and gravel from the central part of the esker near the west boundary of Rickard township was used in the construction of the dam at Twin Falls.

Thick deposits of varved clay are widespread in the area. Some of this clay may be suitable for brick and tile.

Gold

Gold occurs in the Twindyke mine in lot 7, concession IV, Rickard township. It is in quartz and carbonate veins that cut altered pillow lava and diabase and strike about N.80°W. and dip 60°–65°S. The veins contain disseminated and patchy pyrite and chalcopyrite. For distances of 5–10 feet from the veins, the wallrocks are strongly carbonatized regardless of their rock type. Although quartz-carbonate-sulphide veins with the same attitude occur elsewhere in Rickard and Knox townships, none of these veins were found to have widely carbonatized margins or encouraging gold values.

A north-south-striking quartz vein almost 1 foot wide was traced over ¼ mile in lot 3 across the boundary between concession I and concession II of Knox township. Heavy sulphide mineralization was not found. One channel sample across the vein taken by the author contains traces of gold.

Sulphide minerals are widely disseminated throughout the volcanic rocks. Acid pyroclastic bands, in particular, are susceptible to mineralization. Traces of gold and copper were found in a grab sample of mineralized agglomerate in lot 9, concession III, Knox township. Traces of copper and nickel, but no gold or silver, were found in a chip sample taken by the author over a width of 7 feet across a rhyolite tuff band 800 feet south of the Twindyke shaft in Rickard township. The tuff contains nodules of massive pyrite.

A grab sample collected by the author from a heavily mineralized feldspar porphyry dike at Couchiching Falls was assayed and found to contain traces of gold and copper. Knight *et al.* (1919) express the belief that gold mineralization in the area is somehow related to the Algoman(?) porphyry dikes. The porphyry at Couchiching Falls tends to support this belief; but, on the other hand, south-dipping east-west shear zones with veins of the type containing gold at Twindyke mine cut across porphyry dikes. It appears unlikely that the fluids required for veining could be derived from the already consolidated porphyry.

Asbestos

Asbestos occurs in thin 1/32–1/8-inch crossfibre veinlets in serpentinized ultrabasic rocks wherever these rocks are exposed on Lake Abitibi. Consequently the continuation of the same serpentinite mass near the eastern boundary of Kerrs township may also contain asbestos.

Sand and Gravel

The large esker complexes in Rickard and Kerrs townships could be a source of gravel if such materials are ever required for local construction. The core of these eskers consists of coarse sand along with pebbles, cobbles, and boulders. Much of this is suitable for road construction. Coarse material from the esker in the western part of Rickard township was obtained from a pit in lot 12, concession III, and used in dam construction at Twin Falls.

Outward from the central esker core, the proportion of pebbles decreases and the sand becomes finer. In a channel sample taken by the author from the outer edge of the esker in the northwest quarter of lot 12, concession V, Rickard township, 84 percent of the material was finer than 100 mesh, and no material as coarse as 8 mesh was present at all. Such a sand is considered too fine for use in concrete or brick making.

The coarser sands are rich in feldspar; a little magnetite was recorded in several localities. The clay content of the sand is low.

Clay

Varved clay is widespread in the area. Clay banks up to 20 feet high are exposed along the Abitibi River and its inlets. Probably even greater thicknesses of clay are present in parts of the area.

Channel samples of fresh clay were collected from the clay banks, and the results of the ceramic tests performed on these by the Laboratory Branch of the Ontario Department of Mines are presented in Table III.

G. R. Guillet of the Ontario Department of Mines (personal communication) comments that the clays are suitable for certain types of brick and tile; and that samples 63-626 and 63-627, having many of the properties of "stoneware" clay or "sewer-pipe" clay, might with suitable blending form the bulk of an art pottery or sewer-pipe body.

TABLE III—CERAMIC TESTS OF CLAY

SAMPLE No. 63-625
Source: NE.¼, lot 13, concession I, Knox township.
Type: 3-foot channel.
Water of plasticity: 26 percent.
Pyrometric cone equivalent: 4.
Drying shrinkage: 5 percent.

Cone	Fired Shrinkage	Colour	Hardness	24-hour Absorption	5-hour Boil	Saturation Coefficient
	percent			percent	percent	
010	0.5	tan	almost hard	22	24	0.94
06	0.5	cream	hard	22	24.5	0.89
03	2.5	buff	hard	19	22	0.85

SAMPLE NO. 63-626
Source: NW.¼, lot 9, concession V, Knox township.
Type: 2-foot channel.
Water of plasticity: 33 percent.
Pyrometric cone equivalent: 4.
Drying shrinkage: 7–8 percent.

Cone	Fired Shrinkage	Colour	Hardness	24-hour Absorption	5-hour Boil	Saturation Coefficient
	percent			percent	percent	
010	2	tan	very hard	22	23	0.96
06	2.5	cream	very hard	21.5	22.5	0.95
03	7	yellow-buff	very hard	13	14	0.94

SAMPLE NO. 63-627
Source: SW. corner, lot 3, concession VI, Rickard township.
Type: 4-foot channel.
Water of plasticity: 30 percent.
Pyrometric cone equivalent: 4.
Drying shrinkage: 7 percent.

Cone	Fired Shrinkage	Colour	Hardness	24-hour Absorption	5-hour Boil	Saturation Coefficient
	percent			percent	percent	
010	1.8	tan	very hard	20	21	0.97
06	2.7	cream	very hard	19	20	0.95
03	6.4	light-yellow	very hard	13	14	0.95

Description of Properties

Twindyke Mine

The Twindyke mine in the centre of Rickard township is a gold prospect. In 1963 it consisted of ten patented claims owned by Twindyke Mines Limited, six patented claims owned by Riczone Mines Limited, and twelve patented claims owned by MacDyke Oil and Mining Industries Limited.

The Twindyke mine shaft, mine buildings, and surface workings are on claim No. 18405 in the southwest corner of the south half of lot 7, concession IV, Rickard township. Twindyke mine may be reached from Twin Falls by boat or by means of a 7-mile wagon road.

The early history of the mine is described by Knight *et al.* (1919) as follows:

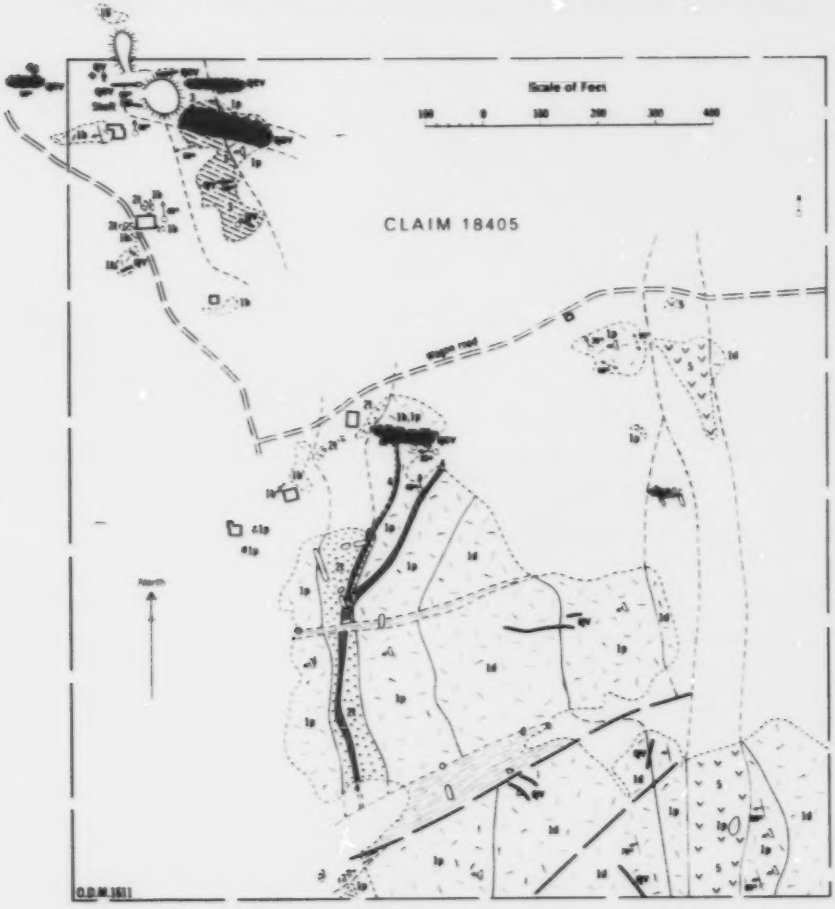
> Gold was found in Rickard township in July, 1917, on the Raty claim (claim No. 18405). Enough underground work was done in the following year to show the ore to be only a small pocket in a large, well mineralized quartz vein . . . The Mining Corporation of Canada, which optioned the property, built camps, installed a steam plant and did considerable underground mining and diamond-drilling. Approximately $110,000 was spent on the property. The late Geo. O. Randolph was in charge of operations, employing at times 50 men. In July, 1918, work was suspended and the claim reverted to the original owners.

A company, Rickard Gold Mines Limited, was formed. Rickard operated the property until 1934 when it was reorganized under the name of Rickard Ramore Gold Mines Limited. More work was done on the property during the forties under its present name of Twindyke Mines Limited.

In 1958, Rio Tinto Canadian Exploration Limited examined the available data and mapped the outcrops on the claims of Twindyke Mines Limited and

Riczone Mines Limited on a scale of 1 inch to 100 feet. Their map was used by the author as a base for remapping the outcrops around the mine. Much of the information given here is based on their report submitted for assessment work credit.

The Mining Corporation of Canada Limited did approximately 2,000 feet of



Geological plan of surface workings of the Twindyke mine.

diamond-drilling, sank a 100-foot shaft inclined at 85°S., and did about 700 feet of drifting and crosscutting at the 100-foot level. During shaft-sinking work, high-grade ore was encountered between the depths of 5 and 14 feet. Little gold was found below 40 feet.

In the 1930s, Rickard Ramore deepened the shaft to 300 feet and did additional diamond-drilling. Twindyke Mines Limited did some further drilling in the forties.

The geology of the prospect is shown on the accompanying sketch map. The gold was found in quartz and quartz-carbonate veins that cut altered pillow lava and Keewatin(?) diabase and dip steeply south. Two main veins are recognized in the shaft area. The more northerly vein strikes about east-west and dips 60°S. It is about 30 inches wide. The more southerly vein strikes N.75°W. and dips 60°S. It consists of a series of stringers in a zone 8 feet wide. The veins were found to unite underground at a point a short distance west of the shaft.

They contain disseminated and patchy pyrite and chalcopyrite, galena, and molybdenite. The pocket of high gold values is reported to have been composed of coarse gold, bismuth telluride, lead telluride, and silver in a crushed-quartz matrix. For distances of 5–10 feet from the veins, the wallrocks are strongly carbonatized to a pale greyish brown rock, regardless of their rock type. The alteration zone in the vicinity of the veins is about 60 feet wide.

A chip sample was collected by the author over a width of 6 feet in a pit north of the shaft. The assay shows: gold—trace; silver—trace; copper—0.35 percent; nickel—trace; lead—trace; molybdenum—trace; bismuth, tellurium, selenium —none.

A series of mineralized east-west shears and veins occurs in a zone 600–1,300 feet south of the shaft. In this zone a strongly pyritized rhyolite tuff band strikes northwards. A chip sample was taken along the length of a pit 1,000 feet south of the shaft and an assay showed traces of gold, silver, copper, and nickel. A number of mineralized quartz-carbonate veins are exposed in this pit.

Schistose basic volcanic rocks with 5–10 percent carbonate in the schistosity planes are exposed northeast of the shaft, in the northeast quarter of the south half of lot 7, concession IV (claim No. 25763 held by Riczone Mines Ltd.).

Bilterijist Claims

Northeast of the Twindyke mine, in Rickard and Knox townships near the Rickard-Knox township boundary, 27 claims were staked. Geophysical work by Lundberg Explorations Limited and diamond-drilling by Rio Tinto Canadian Exploration Limited (who had an option on the property in 1958) did not give encouraging results. The claims have lapsed.

Two of the drillholes reached bedrock of agglomerate cut by grey porphyry. Short sections of core had specks of pyrite, pyrrhotite, and chalcopyrite. One sample contained traces of gold.

Area Mines Limited

In 1963, Area Mines Limited held 11 claims in concessions II and III, Kerrs township, adjacent to the eastern boundary of Kerrs township. These are only part of a claim group extending eastwards to Lake Abitibi.

A magnetic anomaly is present in the claim group. Area Mines Limited

investigated the anomaly in 1963 by detailed ground magnetometer work and by drilling. Two holes were drilled.

A road suitable for motor-vehicle use during favourable summers connects the claim group in Kerrs township with highway No. 101 east of Matheson.

The property is underlain by thick esker deposits. No outcrops were seen on it; but asbestos occurs in thin $\frac{1}{32}$–$\frac{1}{8}$-inch crossfibre veinlets in serpentinized peridotite where these rocks are exposed within the magnetic anomaly on Lake Abitibi. Possibly, therefore, the continuation of the same ultrabasic mass in Kerrs township also contains asbestos.

In reporting on the area to the east of Kerrs township and south of Chesney Bay, Lake Abitibi, the president of Area Mines Limited informed shareholders (31 Dec. 1963):

> Ground surveys were carried out over 43 aerial conductors southwest of Lake Abitibi in Ontario. Six of these were diamond drilled, but none of the sulphides intersected were of ore grade. However, one diamond drill hole showed a 200 foot zone carrying appreciable asbestos fibre. After examination of these cores, your company acquired mineral rights to cover fourteen miles of the favourable formation. This formation was then outlined through detailed magnetic surveys. In carrying out these surveys, your field personnel discovered two outcrops showing a significant fibre content. Over six thousand feet of drilling have now been completed on the property. This involved sixteen holes at wide intervals ranging up to one mile apart. Thirteen of these holes cut substantial widths of serpentinized peridotite carrying asbestos fibre. A very large tonnage of this material is now indicated.
>
> In this large claim group Canadian Nickel Company Limited, a wholly owned subsidiary of International Nickel Company of Canada Limited, has a fifty per cent interest, with your company holding the balance.

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